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(71) Applicant

Alfred Teves GmbH (FR Germany),
7 Guerickestrasse, 6000 Frankfurt am Main, Federal
Republic of Germany

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(72) Inventors

Dieter Kircher
Hubertus von Gruenberg
Klaus-Dieter Blum
Peter Becker

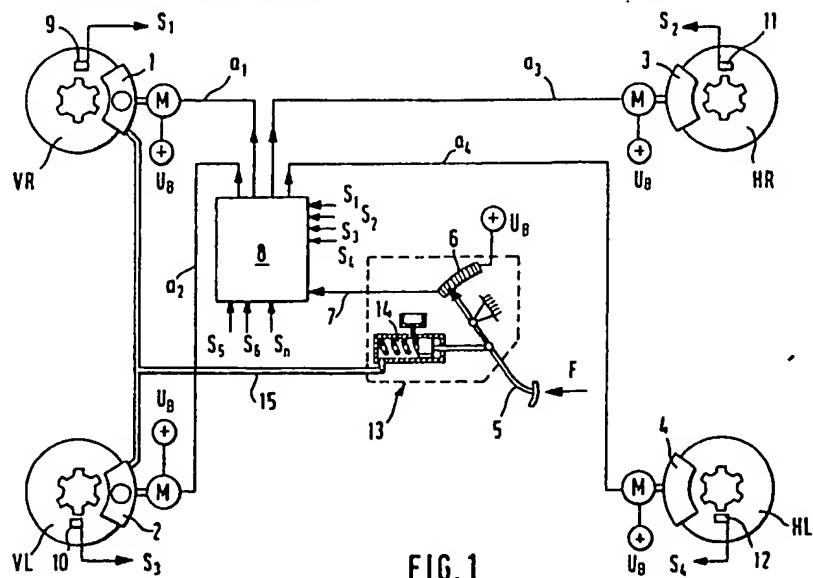
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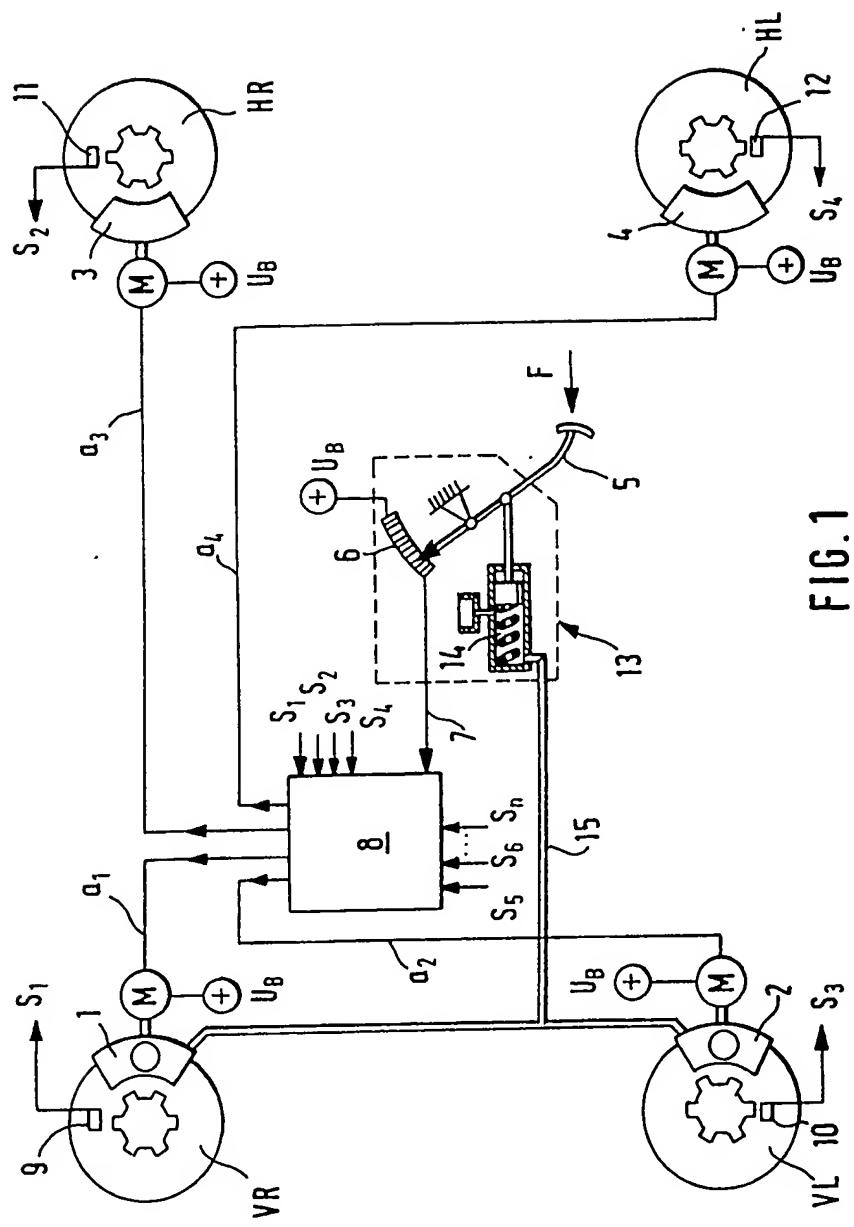
J C Vauvrouard,
ITT Patents Department UK, Maidstone Road, Fooths
Cray, Sidcup DA14 5HT

(54) Process and apparatus for the control of a brake unit for automotive vehicles

(57) Electric signals generated dependent on the operation of the brake pedal (5) are processed in an electronic circuit (8) and logically linked to sensor signals containing information on the brake power, the braking effect and/or on the rotational behaviour of the individual wheels. Electrically actuatable wheel brakes (1, 2, 3, 4, 32, 33), that is to say, wheel brakes (1, 2, 3, 4, 32, 33) equipped with an electric drive (M) are controlled by the signals generated in the aforesaid manner. Through a second brake system, brake power is transmitted by the brake pedal (5, 5') either simultaneously or upon overcoming a threshold value to the wheels of one axle, preferably to the front wheels, i.e. front right, over front left wheels (VR, VL), said brake power becoming, however, effective exclusively in the event of a fault or a failure of the electrical brake system or of the electric power supply.



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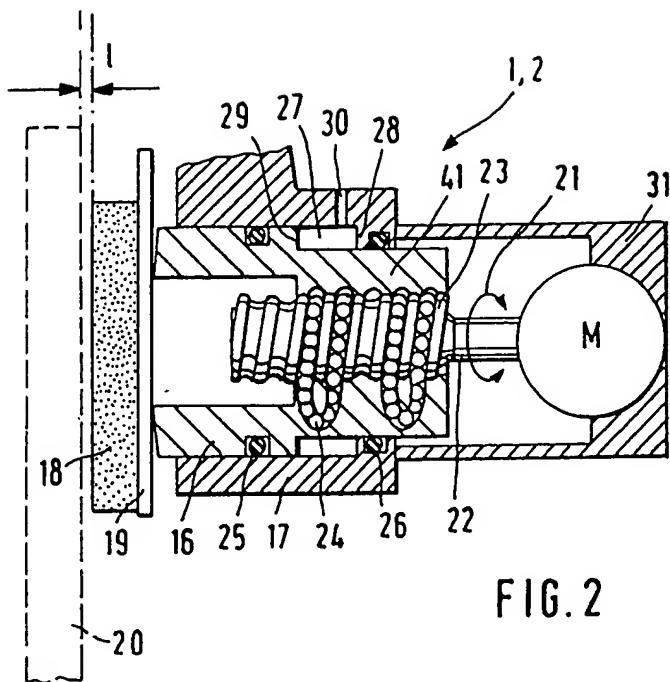


FIG. 2

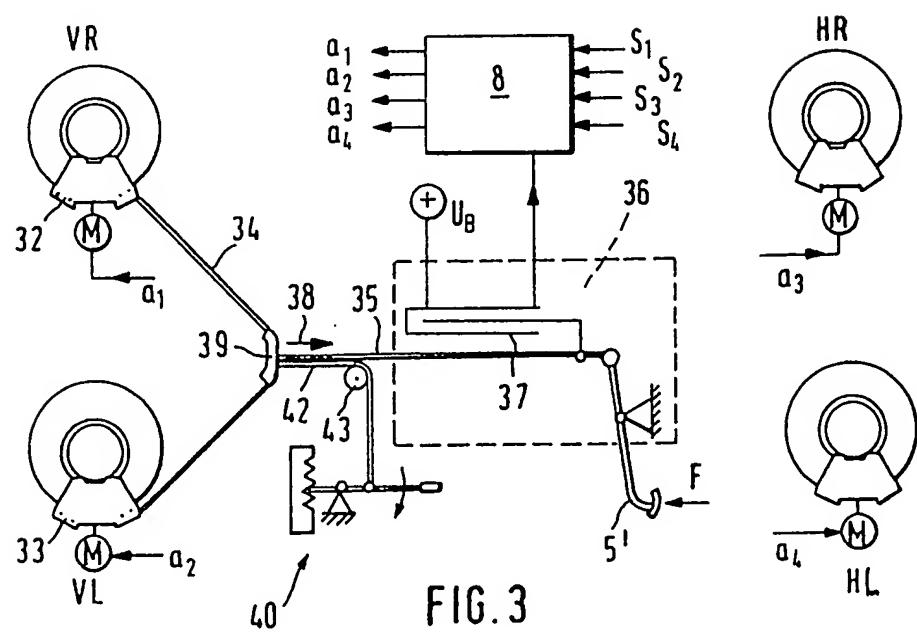


FIG. 3

SPECIFICATION

Process and apparatus for the control of a brake unit for automotive vehicles

- 5 This invention relates to a process for the control of a brake unit provided for automotive vehicles, in particular for road vehicles, in which process an electrical brake system is
- 10 used and in which electrical signals are generated dependent on the operation of the brake pedal, are processed electronically and are logically linked to signals derived from the brake power, the braking effect and/or the
- 15 rotational behaviour of the wheels, and in which electrically actuatable wheel brakes are controlled by means of these signals. Brake units for the realisation of the process and a special application of these brake units are
- 20 also comprised in the subject matter of the present invention.
- Electrical brakes for automotive vehicles are already known in which by means of the brake pedal an ohmic resistance is varied
- 25 which, in its turn, determines the energy flow to an electromagnet that exerts a brake pressure on the pertaining wheel brake corresponding to the power brought to bear on its armature (German patent specification
- 30 851,602). A hand lever may interfere in the lever mechanism which transmits the force from the magnet to the friction lining of the wheel brake and, consequently, a brake pressure independent of the field strength of the
- 35 magnet may be transmitted mechanically to the wheel brake.
- Furthermore an electrical brake system is already known in which an electric motor acts through a spindle on a piston which is, on its
- 40 part, connected hydraulically with the piston of a wheel brake. In this configuration, the control signal to actuate the motor and, therefore, to apply and release the wheel brake is determined by the bridge voltage of a Wheat-
- 45 stone bridge which is furnished with two variable resistances, one of which is adjusted proportionally to the operation of the brake pedal. The setting of the second variable resistance is dependent on the hydraulic brake
- 50 pressure. In addition, a logic intervenes in the bridge circuit, which logic receives output signals from a sensor monitoring the rotational behaviour of the wheels (German patent application published without examination No.
- 55 2,128,169). The brake fails in the event of a failure of the electric power supply or in the event of an electric component becoming defective.
- In a further known electrical vehicle brake
- 60 unit (German patent application published without examination No. 2,926,017) (GB application No. 8019833—Serial No. 2053394), the operation of the brake pedal leads to the generation of a digital signal
- 65 being redundantly transmitted through two
- sensors to a control logic which furnishes output signals for an electric motor dependant on different sensor signals, said electric motor generating, on its part, brake pressure for a
- 70 hydraulic wheel brake through a spindle and a piston of a pressure modulator. This unit, too, requires an emergency brake which renders it possible to brake the vehicle in case of a failure of the source of the electrical energy or
- 75 of a fault in the electrical system. Thus the present invention has for its object to overcome the inconveniences of the known electrical brake systems and to create a process for the control of an electronically controllable
- 80 and adjustable heavy-duty brake unit which allows to be realised in the shape of a comparatively simple brake unit requiring but little effort for its manufacture and which renders it possible to safely brake the vehicle
- 85 even in the event of a failure or a fault of the electric power supply or of the electric components.
- According to one aspect of the present invention there is provided a process for the
- 90 control of a brake unit provided for automotive vehicles, in particular for road vehicles, in which process an electrical brake system is used and electrical signals are generated dependent on the operation of the brake pedal,
- 95 are processed electronically and are logically linked to signals derived from the brake power, the braking effect and/or the rotational behaviour of the wheels, and in which electrically actuatable wheel brakes are con-
- 100 trolled by means of these signals, characterised in that brake power is generated by means of the brake pedal through a second brake system and is transmitted to wheels (VR, VL) of at least one vehicle axle, and in
- 105 that the brake power transmitted through the said second brake system is rendered fully effective exclusively in the event of a fault or a failure of the said electrical brake system.
- The above object has proved to be attainable in a surprisingly simple and technologically advanced manner by means of the present invention.
- According to one embodiment of the present invention, the second brake system is put
- 110 into function automatically as soon as the force exerted on the brake pedal or as soon as the brake pedal travel exceeds a predetermined limit value on account of a fault of the electrical brake system.
- 115 On the other hand, it is also possible to actuate the second brake system simultaneously with the electrical brake system at each operation of the brakes, the second system becoming, however, effective either not at all
- 120 or only to a minor extent, since the electrical brake system has a more elevated brake power boosting and a higher braking effect. In case of a failure of the electrical system, there will then be available at once the second
- 125 system, of which condition the drive will be
- 130

- informed by the higher pedal operating effort required, by a longer pedal travel and/or by signalling.
- In the second brake system, the brake power allows to be transmitted to the wheel brakes of one axle in a particularly simple way mechanically, for example with the aid of a cable or, else, by means of a greatly simplified hydraulic device. Expediently, the second brake system acts on the front wheels which normally receive the higher brake power. The unbraked rear wheels reduce the risk of skidding in this situation.
- According to another embodiment of the inventive process, the second brake system is locked as long as the electrical system and the electric power supply are intact, and is unlocked automatically in the event of a failure or fault of the electrical brake system.
- With the aid of a second system always actuated simultaneously with the electrical brake system, a brake pedal travel simulation for the driver also allows to be realised in a very simple manner.
- For the realisation of the process according to the invention, a brake unit with an electrical brake system is particularly suited which is provided with a brake signal transmitter actuated by the brake pedal and is equipped with sensors and with electronic circuits for the collection, analysing and processing of signals which are derived from the brake pressure, the brake power, the braking effect and/or the rotational behaviour of the wheels, as well as equipped for logic linkage of these signals with the output signals of the brake signal transmitter and which is furnished with electrically actuatable wheel brakes, that is to say, with wheel brakes which are provided with an electric drive and whose particularity consists in that the brake unit is equipped with a second brake system by means of which a brake power determined by the force exerted on the brake pedal is transmittable to the wheels of at least one vehicle axle.
- According to an advantageous embodiment of the brake unit as per the present invention, the second brake system comprises a lever device by which the pedal force is transmittable mechanically, for example through cables, to the wheel brakes of one axle. On the other hand, the second brake system may also be furnished with a master cylinder with a cylinder piston actuated by the brake pedal, which master cylinder is coupled hydraulically with the wheel brakes of one axle, preferably of the front axle. Furthermore, it is of advantage in many cases to envisage a pedal force pick-up unit which is configured as a brake signal transmitter and travel simulator for the electrical brake system and as a brake pressure transmitter or a mechanical brake power translator for the second brake system.
- According to a further embodiment of the invention, it is envisaged to transduce the pedal force into a corresponding digital signal by means of the brake signal transmitter. On the other hand, a voltage or current value analogous to the pedal force may also originate in the brake signal transmitter.
- If according to the invention the second brake system is actuatable, in addition, through a lockable lever arrangement, then this system may also serve as a parking brake.
- Moreover, an advantageous embodiment of the invention consists in that the electrically actuatable wheel brake is designed in the shape of a disc brake whose brake shoes are pressable to the brake disc with the aid of an electric motor which serves as an electric drive, and in that the electric motor is linked, through a spindle positioned in the direction of slide of the brake shoes and through a recirculating ball worm gearing, to an axially slidably supported piston which acts on the brake shoe.
- Expediently, an automatically operating mechanical adjusting device is provided to maintain the predetermined clearance gap between the brake shoes and the brake disc.
- According to the invention, the adjustment of the clearance gap caused by the wear of the brake linings may also be made with the aid of the electric drive, for which purpose a circuit is provided that limits electronically the restoring travel of the piston in accordance with the predetermined clearance gap between the brake disc and the linings when the brake is being released.
- A further expedient embodiment of the inventive brake unit consists in that the piston acting on the brake shoes is located and guided in a liquid-tight manner within the wheel brake in a brake cylinder, namely in such a way that between the rear wall of the cylinder and a surface of the piston a power chamber is formed into which hydraulic pressure is controlled conveyable through the second brake system for an operation of the wheel brakes independent of the actuation of the electric drive.
- On the other hand, it is also possible to press the brake shoes to the brake disc in the wheel brakes independently of the actuation of the electric drive by means of an additional lever arrangement which is coupled to the second brake system.
- The brake unit according to the present invention allows to be used in an ideal manner both to control the distribution of brake power to the front axle and the rear axle of the vehicle dependent on the operation of the brake pedal and on the rotational behaviour of the wheels, in particular dependent on the slip at the front axle, and, in addition, be used for the control of the brake slip and for traction slip control, that is to say, as a means for the prevention of wheel locking, on the one hand, and for the prevention of spinning of wheels as a result of an excessive driving torque, on

the other hand.

Embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

- 5 Figure 1 is a simplified elementary diagram of one embodiment of the invention;
- 10 Figure 2 is a cross-sectional partial view of a wheel brake of the brake unit according to Figure 1; and
- 15 Figure 3 is a further embodiment of the invention, in a form of illustration similar to that of Figure 1.
- 20 The brake unit of Figure 1 is, for example, designed for a passenger vehicle. Each wheel, front right VR, front left VL, rear right HR, rear left HL, is furnished with a spot-type disc brake 1 to 4 which is equipped with an electric drive, namely an electric motor M, that is put into operation on actuation of the brakes and that presses the brake shoes with the requisite force from either side against a brake disc rotating jointly with the wheel.
- 25 In an electrical brake system of the kind shown in Figure 1, the energy required to press the brake shoes to the brake disc is derived from the electrical supply system which is, as a rule, essentially comprised of an accumulator being recharged by means of the generator when the engine is running.
- 30 The source of supply is symbolised with $+ U_B$ in Figure 1. In the embodiment shown, each motor is directly connected to the battery U_B , for which reason the lines a_1 to a_4 have to be considered as control lines which merely
- 35 transfer the instructions for the setting in motion, the stoppage and the reversing of the motor M.
- 40 In an alternative electrical brake system which is not illustrated, both the signals and the required electrical driving energy are transferred over the control lines, so that the individual connections to the source of supply U_B which are outlined in Figure 1 would not be required in that case.
- 45 The force exerted on the brake pedal 5, which generally is the foot brake, when the brake is operated is symbolised with F and an arrow. In this configuration, the pedal travel of the brake pedal 5 is transmitted through a
- 50 sliding contact to an adjustable ohmic resistance 6 which feeds an electric signal corresponding to the pedal force F, or, equally satisfactorily, to the pedal travel, through a signalling line 7 into an electronic circuit 8.
- 55 With the aid of the said electronic circuit 8 which may also be realised in the shape of one or several programme-controlled micro-computers, sensor signals S_1 to S_n are logically linked among one another and to the
- 60 brake actuation signal transmitted through the signalling line 7. Control signals are generated in this way which are supplied through the lines a_1 to a_4 to the electric driving motors M of the individual wheel brakes 1 to 4.
- 65 The inputs for the sensor signals S_1 to S_n

are connected with wheel sensors 9 to 12 arranged at the individual wheels, by which sensors 9 to 12 voltages are picked up inductively in co-operation with the indicated

- 70 toothed discs, the frequencies and frequency changes of said voltages allowing the drawing of conclusions on the rotational speed of the wheels and on their rotational behaviour.
- 75 Depending on the specific design of the brake unit, further sensors are connected through the sensor inputs S_5 , S_6 ... S_n which allow to cover, for example, the brake torques at the individual wheels, the translation deceleration of the vehicle and/or other variables
- 80 to be measured which are determined by the braking effect. In many cases, however, the sensor signals S_1 to S_4 will be sufficient, since adopting a skilful logic linkage they allow to detect the slip at the individual wheels, the
- 85 individual wheel deceleration and acceleration, a variable approximating the vehicle speed, etc. to serve as actuating and controlling variables for the brake system.

- In the embodiment according to Figure 1,
- 90 the pedal force pick-up unit designated in its entirety with the reference numeral 13 and framed by a dashed line in the illustration comprises one single master cylinder 14 by means of which hydraulic pressure is built up
 - 95 on operation of the brake pedal 5, said hydraulic pressure being conveyed to the wheel brakes 1, 2 of the front right and front left wheels VR, VL through the hydraulic line 15. This hydraulically transmitted brake pressure
 - 100 which is generated in this configuration simultaneously with the signals to control the electrical brake system when the pedal 5 is operated does, however, not become effective at all or become effective only at a negligible extent as long as the electrical brake system and the electric power supply are sound, because auxiliary energy to boost the pedal force F is made available exclusively to the electrical brake system, namely in the form of
 - 105 electrical energy to drive the motors M.

A comparatively low brake power boosting in the second brake system can also be provided if necessary.

- In the event of a failure of the electric power supply, of a defect or of a transitory fault, the front wheel brakes 1, 2 will, however, be supplied immediately with brake pressure through the brake pedal 5 and the master cylinder 14, so that at least an emergency stop remains possible anyway.

For reasons of safety, the electrical brake system is designed in such a manner that any defect and any failure of the electrical energy leads to the release of the electrically driven system of the wheel brakes.

Instead of the sliding contact 6, that means an adjustable ohmic resistance, it is expedient to employ a transducer which immediately generates a digitally encoded signal corresponding to the pedal force F and transmits it

to the circuit 8. In the embodiment according to Figure 1, a simulation of the pedal travel and a force directed contrary to the direction of the pedal force F are, for example, caused by a spring in the master cylinder 14.

By means of the logical linkage with the sensor signals of the control signal which is proportional to the force F and is supplied over the line 7, the actual value of the brake power, of the braking effect, of the slip or of other, derived variables is electronically compared at each wheel with the rated value determined by the pedal force F exerted by the driver, and is adjusted to equal the rated value. In this manner, tolerances, wear, and differing conditions at the individual wheels are balanced automatically.

With the aid of the circuit 8, a brake slip control which prevents the wheels from locking therefore allows to be included with but little additional design efforts in the electric control system and especially in the electronic linkage. Obviously, it is also possible to extend the system for the purpose of limitation of the traction slip.

Figure 2 illustrates a possibility of realisation of the front wheel brake 1 or 2 of a brake unit according to Figure 1. Only piston 16 in cylinder housing 17 of a wheel brake structured according to the principle of a hydraulically actuated fist-type caliper disc brake is shown in Figure 2 in an axial cross-section. With the aid of the piston 16 which is axially slidable within the housing 17 of the disc brake, a brake shoe 18, 19 being in abutment against the left front surface of the piston 16 as viewed in Figure 1 and consisting of the lining 18 and the lining carrier 19 is pressed against a brake disc 20 shown in dashed lines, for which purpose the piston 16 with the brake shoe 18, 19 must first overcome the clearance gap 1.

In this case, an electric motor M, in particular a direct current motor, which can be driven in either sense of rotation, as indicated by the double arrow 21, serves to electrically drive the piston 16. Through a shaft 22 driven by the electric motor M, the rotary motion is transmitted to a worm shaft or spindle 23 and by means of the latter through an internal thread in a rear wall 41 to the piston 16.

The device for the transformation of the rotary motion into a longitudinal motion shown in Figure 2 is constituted by a recirculating ball worm gearing which is essentially comprised of the spindle 23, balls 24 received within closed spirals, and the internal thread in the rear wall 41 of the piston 16. In this configuration, the balls 24 are arranged within two double spirals for improved and uniform power transmission.

The piston 16 is configured as a stepped piston whose portion engaging with the spindle 23 passes through rear wall 28 of the

cylinder housing 17.

Sealing rings 25, 26 are arranged within the cylinder housing 17 as well as in the range of the passage through the rear wall 28

of the cylinder housing 17 in order that an annular chamber 27 is formed in the housing 17 between the housing rear wall 28 and a step 29 of the stepped piston 16, into which annular chamber 27 hydraulic pressure is allowed to be controlledly conveyed through a connecting port 30.

When the annular chamber 27 is connected hydraulically with the exit of the master cylinder 14—compare Figure 1—via the inlet port,

30, the piston 16 and together with it the brake shoe 18, 19 are movable both by the electrical brake system, through the electric driving motor M and, independently of the electric drive, through the second brake system 14, 15, 27. It is of importance in this context that the recirculating ball worm gearing employed in the embodiment described has no nonreversibility so that—in contrast to simple worm gearings of high transmission

ratio—a power transmission can take place both from the spindle 23 to the piston 16 and viceversa.

In this instance, the motor M is coupled to the cylinder housing 17, 28 through a rigid housing 31.

In disc brakes, the clearance gap 1 must, on principle, not exceed a certain value, for which purpose a lining self-adjustment is customarily provided to balance the wear of the lining. In the electrical brake system employed in accordance with the present invention, the clearance gap adjustment is carried out by electronic control at the moment the piston 16 is restored upon the release of the brake.

105 This allows to be realised in different ways. For example, the lifting-off of the brake shoe from the brake disc 20 can be detected by a contact or by a pressure sensor and thereupon the restoration of the piston be immediately stopped.

The wheel brakes 3, 4 in the embodiment according to Figure 1 do not require any hydraulic connection. For reasons of simplicity, brakes of identical type can, however, be used both at the front right, front left wheels VR, VL and at the rear right, rear left wheels HR, HL:

According to a further, particularly simple-design embodiment which is illustrated in

120 Figure 3, a mechanical brake power transmission with the aid of a cable assembly is used for the second brake system instead of the hydraulic system described in the foregoing with reference to Figures 1 and 2. In this

125 version, wheel brakes 32, 33 are arranged at the front right, front left wheels VR, VL which can be operated both through an electric drive M and through a cable assembly 34, 35. The pedal force pick-up unit 36 comprises a lever arrangement in this embodiment by means of

- which an operation of the brake pedal 5', a travel simulator and brake signal transmitter 37 is actuated, on one hand, which latter transmits signals to the electronic circuit 8
- 5 which are proportional to the pedal effort, and in which tractive force is exerted, on the other hand, through the cable 35 on a sleeve 39 in the direction of the arrow 38, said sleeve 39 uniformly conveying that tractive force via the
- 10 cable 34 to the mechanical power-supply connection of the wheel brakes 32, 33.
- Also in this case, the braking effect of the electrical brake system, of which only the electronic circuit 8, the signal outputs a_1 to a_4
- 15 and the electric driving motors M are illustrated in the diagram, is higher than the braking effect through the cable assembly 34, 35, so that the mechanical brake power transmission to the front wheels becomes effective only in the event of a fault or a failure of the electrical brake system.
- The mechanical brake through the cable assembly 34, 35 and the front wheel brakes 32, 33 according to Figure 3 can also be
- 20 employed as a parking brake. It will be sufficient for this purpose to provide a locking lever making catch at the cable 35 or being fastened to the sleeve 39 via a separate cable 42 and an angle sheave 43 to lock the mechanically operated front wheel brakes 32, 33 in the applied condition. The whole lever arrangement with a symbolically outlined notched arrest is designated with reference numeral 40 in Figure 3.
- 25 In the embodiments described on the basis of Figures 1 to 3, the second brake system is actuated simultaneously with the electrical brake system. As an alternative, it will, however, be possible also to first lock the second
- 30 brake system, for example with the aid of a magnetically controlled latch, and to release it only in the event of a failure of the current supply or of a fault of the electrical brake system.
- 35 Furthermore, it may be expedient to initiate the actuation of the second brake system only after the brake pedal 5, 5' has travelled a certain distance or after the force F has exceeded a threshold value. Also a combination
- 40 of the variety of conditions for the putting into operation of the second brake system is reasonable.
- The object of safeguarding a safe braking of the vehicle even in the event of a failure of
- 45 the electric power supply and of a fault or of a defect of a component is, therefore, attained in a very simple manner by the inventive process and the relevant apparatus, using a substantially electrical brake unit.
- 50 The advantages offered by electrical brake units and by the electronic control are therewith combined with the advantages of non-electrical systems.
- If the use of hydraulic fluid in the wheel
- 55 brake is foregone or if the requirements the

hydraulic fluid contained in the wheel brake has to meet are alleviated, the admissible operating temperature in the wheel brake will allow to be increased considerably.

- 70 The integration of the inventive brake unit with brake slip and traction slip control systems becomes possible with minimum additional efforts.
- 75 CLAIMS
1. A process for the control of a brake unit provided for automotive vehicles, in particular for road vehicles, in which process an electrical brake system is used and electrical signals
 - 80 are generated dependent on the operation of the brake pedal, are processed electronically and are logically linked to signals derived from the brake power, the braking effect and/or the rotational behaviour of the wheels,
 - 85 and in which electrically actuatable wheel brakes are controlled by means of these signals, characterised in that brake power is generated by means of the brake pedal (5, 5') through a second brake system and is
 - 90 transmitted to wheels (VR, VL) of at least one vehicle axle, and in that the brake power transmitted through the said second brake system is rendered fully effective exclusively in the event of a fault or a failure of the said
 - 95 electrical brake system.
2. A process as claimed in claim 1, characterised in that the said second brake system is put into function automatically as soon as the force (F) exerted on the brake pedal (5, 5')
 - 100 exceeds a predetermined threshold value.
 3. A process as claimed in claim 1 or claim 2, characterised in that the said second brake system is put into function automatically as soon as the brake pedal travel exceeds a
 - 105 predetermined value.
 4. A process as claimed in claim 1, characterised in that the said second brake system is put into function simultaneously with the said electrical brake system by the operation of the
 - 110 brake pedal (5, 5'), but has a lower braking effect or brake power boosting as compared to the said electrical brake system and does, therefore, not become effective at all or become effective only partly when the said electrical brake system is intact.
 - 115 5. A process as claimed in any one of claims 1 to 4, characterised in that in the said second brake system, the brake power is transmitted mechanically to the wheel brakes.
 - 120 6. A process as claimed in claim 5, characterised in that the said second brake system is simultaneously employed as a parking brake.
 7. A process as claimed in any one of claims 1 to 4, characterised in that in the said
 - 125 second brake system, the brake power is transmitted hydraulically to the wheel brakes (1, 2).
 8. A process as claimed in claim 1, characterised in that the said second brake system, is locked when the said electrical brake sys-

- tem is intact, and is unlocked automatically in the event of a failure or fault of the said electrical brake system.
9. A process as claimed in any one of 5 claims 1 to 8, characterised in that the brake pedal travel or the brake pedal force is simulated for the driver with the aid of the said second brake system.
10. A brake unit for the realisation of the 10 process as claimed in any one of claims 1 to 9, with an electrical brake system which is furnished with a brake signal transmitter actuated by the brake pedal and is equipped with sensors and with electronic circuits for the 15 collection, analysing and processing of signals which are derived from the brake pressure, the brake power, the braking effect and/or the rotational behaviour of the wheels, as well as equipped for logic linkage of these signals 20 with the output signals of the said brake signal transmitter and which is furnished with electrically actuatable wheel brakes, that is to say, with wheel brakes which are provided with an electric drive, characterised in that the 25 said brake unit is equipped with a second brake system (14, 15, 27; 34, 35, 39) by means of which a brake power determined by the force (F) exerted on the brake pedal (5, 5') is transmittable to wheels (VR, VL) of at least 30 one vehicle axle.
11. A brake unit as claimed in claim 10, characterised in that the power generated by the said second brake system is transmittable to the wheels (VR, VL) exclusively in the event 35 of a failure or fault of the said electrical brake system.
12. A brake unit as claimed in claim 10, characterised in that the brake power transmitted through the said second brake 40 system has a lower braking effect as compared to the brake power exerted through the said electrical system.
13. A brake unit as claimed in any one of 45 claims 10 to 12, characterised in that the said second brake system comprises a lever device by means of which the pedal force is transmittable mechanically, for example through a cable assembly (34, 35), to the wheel brakes (32, 33) of one axle.
- 50 14. A brake unit as claimed in any one of claims 10 to 12, characterised in that the said second brake system is furnished with a master cylinder (14) actuated by the brake pedal (5, 5'), which said master cylinder (14) is 55 coupled hydraulically with the wheel brakes (1, 2) of one axle.
15. A brake unit as claimed in claim 13 or 60 claim 14, characterised in that the said wheel brakes (1, 2) coupled with the said second brake system are connected to the front axle.
16. A brake unit as claimed in any one of 65 claims 10 to 15, characterised in that the said brake unit is furnished with a pedal force pick-up unit (13, 36) or a brake pedal travel pick-up which is configured as a brake signal

- transmitter and travel simulator or force simulator for the said electrical brake system and as a brake pressure transmitter or a mechanical brake power translator for the said second brake system.
- 70 17. A brake unit as claimed in claim 16, characterised in that the said brake signal transmitter is substantially constituted by a transducer which transduces the pedal force (F) into a digital signal.
18. A brake unit as claimed in claim 16, characterised in that the said brake signal transmitter is substantially constituted by a transducer which transduces the pedal force (F) into an analogous voltage or current value.
19. A brake unit as claimed in claim 14, characterised in that the said master cylinder (14) is simultaneously configured as a travel simulator for the said electrical brake system.
- 80 20. A brake unit as claimed in any one of claims 10 to 19, characterised in that the said second brake system is actuatable in addition through a lockable lever arrangement (40) and simultaneously serves as a parking brake.
21. A brake unit as claimed in any one of claims 10 to 20, characterised in that the said electrically actuatable wheel brake (1, 2) is designed as a disc brake whose brake shoes (18, 19) are pressable to the brake disc (20, 20') with the aid of an electric motor (M) which serves as an electric drive, and in that the said electric motor (M) is linked, through a spindle (23) positioned in the direction of slide of the said brake shoes (18, 19) and through a recirculating ball worm gearing (23, 24, 41), to an axially slidably supported piston (16) which acts on the said brake shoe (18, 19).
22. A brake unit as claimed in claim 21, 105 characterised in that the wheel brakes (1, 2, 3, 4; 32, 33) are equipped with automatic mechanical adjusting devices which keep constant the clearance gap between the brake disc and the brake shoes or limit it to a predetermined maximum value.
23. A brake unit as claimed in claim 21, characterised in that the wheel brakes (1, 2, 3, 4) are provided with an adjusting device which is actuated electrically by means of the 110 electric drive (M).
24. A brake unit as claimed in claim 23, characterised in that the restoring travel of the said piston (16) is limitable electronically in accordance with the predetermined clearance 115 gap (1) between the said brake disc (20) and the said brake shoes (18, 19) when the brake is being released.
25. A brake unit as claimed in any one of claims 21 to 24, characterised in that the said 120 piston (16) acting on the said brake shoe (18, 19) is located and guided in a liquid-tight manner within the said wheel brake (1, 2) in a brake cylinder (17), so that between the cylinder rear wall (28) and a surface (29) or step 125 of the said piston (16) a power chamber (27)

is formed into which hydraulic pressure, that is hydraulic fluid, is controlledly conveyable through the said second brake system, that is to say, independently of the actuation of the
5 said electric drive (M) of said wheel brake (1,2).

26. A brake unit as claimed in any one of claims 21 to 24, characterised in that the
brake shoes are pressable to the brake disc in
10 the said wheel brakes (32, 33) independently of the actuation of the said electric drive (M)
by means of a lever arrangement which is additional to the said electric drive (M).

27. An application of the brake unit as
15 claimed in any one of claims 10 to 26 for the purpose of the control of the brake power distribution to the front and to the rear wheels (VR, VL, HR, HL) dependent on the pedal operation and on the rotational behaviour of
20 the wheels as well as for the purpose of limiting and control of the brake slip and of the traction slip.

28. A process for the control of a brake unit provided for automotive vehicles substantially
25 as herein described with reference to Figures 1 and 2 or Figure 3 of the accompanying drawings.

29. A brake unit for automotive vehicles substantially as herein described with reference to Figures 1 and 2 or Figure 3 of the accompanying drawings.

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